CLAIMS

I claim:

1. A fluid machine comprising:

a housing defining an interior, the housing having a port in communication with the interior of the housing;

at least one primary vane disposed within the interior of the housing that rotates about a primary axis;

at least one secondary vane disposed within the interior of the housing, the secondary vane pivotally oscillating between alternating open and closed positions with respect to the primary vane and defining a chamber within the housing interior having a volume which varies as the primary vane is rotated about the primary axis; and

an actuator for varying the point during rotation of the primary vane at which the secondary vane reaches the open and closed positions relative to the port so that communication of the port with the chamber is adjusted.

2. The fluid machine of claim 1, wherein the actuator varies the point during rotation of the primary vane at which the secondary vane reaches the open and closed positions so that the rate of fluid flow through the machine is varied.

3. The fluid machine of claim 1, wherein the actuator varies the point during rotation of the primary vane at which the secondary vane reaches the open and closed positions so that the direction of fluid flow through the machine is reversed while the direction of rotation of the primary vane remains substantially constant.

4. The fluid machine of claim 1, wherein:

the actuator includes a control member that is adjusted relative to the housing to varying the point during rotation of the primary vane at which the secondary vane reaches the open and closed positions so that the degree of communication of the port with the chamber is adjusted.

5. The fluid machine of claim 4, wherein:

the control member is a control plate which couples to the housing.

6. The fluid machine of claim 4, wherein:

the control member is a control lever.

7. The fluid machine of claim 1, wherein there are two ports formed in the housing.

8. The fluid machine of claim 1, wherein at least a substantial portion of the secondary vane is hollow.

9. The fluid machine of claim 1, wherein the secondary vane is formed as two halves that are joined together, and wherein at least one of the secondary vane halves has recessed areas formed therein.

10. The fluid machine of claim 1, wherein the exterior of the housing is contoured to provide increased surface area to facilitate cooling of the machine.

11. The fluid machine of claim 1, wherein the exterior of the housing is provided with a plurality of outwardly projecting ribs.

12. The fluid machine of claim 1, wherein the fluid machine is a motor.

13. The fluid machine of claim 1, wherein the fluid machine is a fluid pump.

14. The fluid machine of claim 1, wherein the fluid machine is a fluid compressor.

15. The fluid machine of claim 1, wherein the actuator varies the point during rotation of the primary vane at which the secondary vane reaches the open and closed positions so that the rate of fluid flow through the machine is adjusted while the direction of rotation of the primary vane remains substantially constant.

16. The fluid machine of claim 1, wherein:

the actuator is adjustable to vary the lower limit of the size of the volume of the chamber defined by the primary and secondary vane that is in communication with the port.

17. A fluid machine comprising:

a housing defining an interior, the housing having a port in communication with the interior of the housing;

at least one primary vane disposed within the interior of the housing that rotates about a primary axis;

at least one secondary vane disposed within the interior of the housing, the secondary vane pivotally oscillating between alternating open and closed positions with respect to the primary vane and defining a chamber within the housing interior having a volume which varies as the primary vane is rotated about the primary axis; and

an actuator that is adjustable to vary the lower limit of the size of the volume of the chamber defined by the primary and secondary vane that is in communication with the port.

18. A fluid machine comprising:

a housing defining an interior, the housing having at least two fluid ports in communication with the interior of the housing;

a primary vane disposed within the interior of the housing;

a rotary shaft having a primary axis that couples to the primary vane and rotates the primary vane about the primary axis;

a secondary vane mounted within the housing for pivotal movement between open and closed positions with respect to the primary vane, the secondary vane pivoting about a pivotal axis passing through the primary vane as the primary vane rotates, the primary and secondary vanes dividing the interior of the housing into chambers with the volume of the chambers varying as the secondary vane is moved between the open and closed positions; and

a guide that causes the secondary vane to move between the open and closed positions and directs diametrically opposed points of the secondary vane to rotate about a secondary vane rotational axis that intersects but which is angularly offset from the primary axis as the primary vane is rotated, the primary axis and secondary vane rotational axis defining a control plane; and

wherein the guide can be adjusted to orient the control plane in two or more positions so that communication of the ports with the chambers is adjusted to thereby regulate fluid flow through the machine.

19. The fluid machine of claim 18, wherein the rate of fluid flow through the machine is varied by adjusting the orientation of the control plane.

20. The fluid machine of claim 18, wherein the direction of fluid flow through the machine is reversed by adjusting the orientation of the control plane while the direction of rotation of the primary vane remains substantially constant.

21. The fluid machine of claim 1, wherein the rate of fluid flow through the machine is adjusted by adjusting the orientation of the control plane while the direction of rotation of the primary vane remains substantially constant.

22. A fluid machine comprising:

a housing defining a generally spherical interior, the housing having a fluid inlet and a fluid outlet in communication with the interior of the housing;

a primary vane disposed within the interior of the housing;

a rotary shaft having a primary axis of rotation mounted to the housing, the primary vane being coupled to the rotary shaft so that the primary vane is rotated about the primary axis by the rotary shaft;

a fixed shaft which extends into the interior of the housing opposite the rotary shaft, the fixed shaft having a spherical end portion about which the primary vane rotates, the fixed shaft being adjustably mounted to the housing so that the fixed shaft can be oriented in various fixed positions;

a carrier ring rotatably carried on the spherical end portion of the fixed shaft, the axis of rotation of the carrier ring being oriented at an oblique angle in relation to the primary axis;

a secondary vane pivotally mounted to the rotary shaft so that the secondary vane is pivotal about an axis perpendicular to the primary axis to allow the secondary vane to pivot between open and closed positions with respect to the primary vane as the primary and secondary vanes are rotated together by the rotary shaft about the primary axis, the primary and secondary vanes dividing the interior of the housing into chambers with the volume of the chambers varying as the secondary vane is moved between the open and closed positions, the secondary vane being pivotally coupled to the carrier ring so that the secondary vane is pivotal about an axis perpendicular to the carrier ring's axis of

rotation, the rotation of the carrier ring causing the secondary vane to reciprocate between the open and closed positions as the secondary vane is rotated about the primary axis by the rotary shaft; and wherein

the degree of communication of the inlet and outlet ports with the chambers is adjusted by moving the fixed shaft to a different fixed position.

23. The fluid machine of claim 22, wherein the rate of fluid flow through the machine is adjusted by varying the position of the fixed shaft.

24. The fluid machine of claim 22, wherein the direction of fluid flow through the machine is reversed by varying the position of the fixed shaft while the direction of rotation of the rotary shaft remains substantially constant.

25. The fluid machine of claim 22, wherein:

the fixed shaft is rotatably mounted to the housing; and further comprising:

a control lever coupled to the fixed shaft for selectively rotating the fixed shaft to the various fixed positions.

26. The fluid machine of claim 22, further comprising a control member that couples to the fixed shaft for maintaining the fixed shaft at a selected fixed position.

27. The fluid machine of claim 22, wherein there are two inlets and two outlets formed in the housing.

28. The fluid machine of claim 22, wherein at least a substantial portion of the secondary vane is hollow.

29. The fluid machine of claim 22, wherein the secondary vane is formed as two halves that are joined together, and wherein at least one of the secondary vane halves has recessed areas formed therein.

30. The fluid machine of claim 22, wherein the primary and secondary vanes divide the interior of the housing into four chambers.

31. The fluid machine of claim 22, wherein the secondary vane is pivotally mounted to the rotary shaft by pivotally coupling the secondary vane to the primary vane.

32. The fluid machine of claim 22, wherein the fixed shaft is moved to the various fixed positions by rotating the fixed shaft about an axis coaxial with the primary axis.

33. The fluid machine of claim 22, wherein the exterior of the housing is contoured to provide increased surface area to facilitate cooling of the machine.

34. The fluid machine of claim 22, wherein the exterior of the housing is provided with a plurality of outwardly projecting ribs.

35. The fluid machine of claim 22, wherein the fluid machine is a motor.

36. The fluid machine of claim 22, wherein the fluid machine is a fluid pump.

37. The fluid machine of claim 22, wherein the fluid machine is a fluid compressor.

38. The fluid machine of claim 22, wherein the rate of fluid flow through the machine is adjusted by varying the position of the fixed shaft, while the rotary shaft is rotated at a generally constant rate.

39. A method of regulating fluid flow in a fluid machine comprising:

providing a housing of the machine that defines a housing interior, the housing having a port in communication with the interior of the housing through which fluid from a fluid source is allowed to flow;

providing at least one primary vane disposed within the interior of the housing that rotates about a primary axis;

providing at least one secondary vane disposed within the interior of the housing;

rotating the primary vane about the primary axis with the secondary vane pivotally oscillating between alternating open and closed positions with respect to the primary vane defining a fluid chamber for containing fluid within the housing interior having a volume that varies as the primary vane is rotated about the primary axis; and

varying the point at which the secondary vane reaches the open and closed positions relative to the port so that the degree of communication of the port with the fluid chamber defined by the primary and secondary vanes can be adjusted to vary the fluid flow through the port.

40. The method of claim 39, wherein the direction of fluid flow is reversed by varying the point at which the secondary vane reaches the open and closed positions relative to the port.

41. The method of claim 40, wherein the direction of rotation of the primary vane about the primary axis remains substantially constant.

42. The method of claim 39, wherein the rate of flow of the fluid through the device is changed by varying the point at

which the secondary vane reaches the open and closed positions relative to the port.

43. The method of claim 42, wherein the rate of rotation of the primary vane about the primary axis is maintained substantially constant.

44. The method of claim 39, wherein the fluid is a compressible fluid.

45. The method of claim 39, wherein the fluid is a non-compressible fluid.

46. A method of regulating fluid flow in a fluid machine comprising:

providing a housing of the machine having a hollow interior and having at least two fluid ports in communication with the housing interior, at least one of the ports connected to a fluid source;

rotating a primary vane within the interior of the housing about a primary axis;

providing a secondary vane that is mounted within the housing for pivotal movement between open and closed positions with respect to the primary vane, the secondary vane pivoting about a pivotal axis passing through the primary vane as the primary vane rotates, the primary and secondary vanes dividing the interior of the housing into chambers, with the volume of the chambers varying as the secondary vane is moved between the open and closed positions;

guiding the secondary vane to move between the open and closed positions so that diametrically opposed points on the secondary vane rotate about a secondary vane rotational axis that intersects but which is angularly offset from the primary axis as the primary vane is rotated, the primary axis and secondary vane rotational axis defining a control plane; and

adjusting the orientation of the control plane in two or more positions so that communication of the ports with the chambers is adjusted to thereby regulate fluid flow through the machine.

47. The method of claim 46, wherein the direction of fluid flow is reversed by adjusting the orientation of the control plane.

48. The method of claim 47, wherein the direction of rotation of the primary vane about the primary axis remains constant.

49. The method of claim 46, wherein the rate of flow of the fluid through the device is changed by adjusting the orientation of the control plane.

50. The method of claim 49, wherein the rate of rotation of the primary vane about the primary axis is maintained substantially constant.

51. The method of claim 49, wherein the fluid is a compressible fluid

52. The method of claim 46, wherein the fluid is a non-compressible fluid.

53. A method of regulating fluid flow in a fluid machine comprising:

providing a housing of the machine having a spherical hollow interior and having first and second fluid ports that are spaced apart from each other to provide fluid communication between the exterior of the housing and the interior, at least one of the first and second ports connected to a fluid source;

providing a primary vane disposed within the housing, the primary vane being rotatable about a primary axis;

providing a fixed shaft that extends into the housing interior, the fixed shaft having a spherical end portion disposed within the interior about which the primary vane rotates, the fixed shaft being adjustably mounted to the housing so that the fixed shafted can be oriented in various fixed positions;

providing a carrier ring rotatably mounted on the spherical end portion of the fixed shaft, the carrier ring rotating about a carrier ring axis that is oriented at an oblique angle with respect to the primary axis;

providing a secondary vane that is pivotally mounted to the primary vane so that the secondary vane is pivotal about an axis perpendicular to the primary axis to allow the secondary vane to pivot between open and closed positions with respect the primary vane as the primary and secondary vane are rotated together about the primary axis, the primary and secondary vanes dividing the interior of the housing into chambers, the secondary vane being pivotally coupled to the carrier ring so that the secondary vane is pivotal about an axis perpendicular to the carrier ring axis;

rotating the primary and secondary vane about the primary axis while the fixed shaft is in a first fixed position, the rotation of the secondary vane about the primary axis causing the carrier ring to rotate about the carrier ring axis and thus cause the secondary vane to reciprocate between the open and closed positions as the primary and secondary vane are rotated about the primary axis, the primary and secondary vanes defining an inlet chamber as the secondary vane is reciprocated to the open position so that fluid enters the inlet chamber through the first port while the first port is in communication with the inlet chamber, and wherein the primary and secondary vanes define a discharge chamber as the secondary vane is reciprocated to the closed position so that fluid exits the discharge chamber through the second port while the second port is in communication with the discharge chamber; and

moving the fixed shaft to a second position so that the degree of communication of the first and second ports with the inlet and discharge chambers defined by the primary and secondary vanes as the primary and secondary vanes are rotated about the primary axis is changed to vary the fluid flow through the machine.

54. The method of claim 53, wherein the direction of fluid flow is reversed when the fixed shaft is moved to the second position, the first port communicating with the discharge chamber and the second port communicating with the inlet chamber when the fixed shaft is in the second position.

55. The method of claim 54, wherein the direction of rotation of the primary and secondary vanes about the primary axis remains substantially constant.

56. The method of claim 53, wherein the rate of flow of the fluid through the device is changed when the fixed shaft is moved to the second position.

57. The method of claim 56, wherein the rate of rotation of the primary and secondary vanes about the primary axis is maintained substantially constant.

58. The method of claim 53, wherein a lever is provided with the fixed shaft to facilitate rotating of the fixed shaft to the second fixed positions.

59. The method of claim 53, wherein a control member is provided with the fixed shaft, the control member mounting to the housing and engaging the fixed shaft so that the fixed shaft is maintained in the desired fixed position.

60. A race assembly of a spherical fluid machine for causing a reciprocating vane of the fluid machine to oscillate back and forth while rotating about a primary axis within a housing of the fluid machine, the race assembly comprising:

a carrier ring shaft that mounts within the housing of the fluid machine;

a carrier ring for coupling to the reciprocating vane, the carrier ring rotatably mounting to the carrier ring shaft so that the carrier ring rotates about a second axis that is at an oblique angle with respect to the primary axis;

a first shaft end portion that is joined to one end of the carrier ring shaft; and

a second shaft end portion that mounts to the other end of the carrier ring shaft and is secured thereto by at least two removable fasteners that are eccentrically located with respect to the second axis.

61. A vane for a rotary vane fluid machine comprising:

a vane member wherein at least a substantial portion of the vane member is hollow so that the weight of the vane is reduced.

62. The vane of claim 61, wherein:

the vane is formed as two halves that are joined together, and wherein at least one of the vane halves has a recessed area formed therein.

63. A housing for a rotary vane fluid machine, comprising:

a housing body having an exterior surface that is contoured to provide increased surface area for heat transfer.

64. A housing for a rotary vane fluid machine, comprising:

a housing body having a plurality of outwardly projecting ribs formed on the exterior of the housing body.